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Creation of Optimal Combinations of Biosorbents to Eliminate Excessive Amounts of Metals from the Human Body

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Abstract
Results of the development and evaluation of a sorption capacity of several polymer biosorbents combined with an inorganic matrix are provided. The potential use of whey to model sorption processes in an internal environment of the body is shown. Most effective combinations promoting selective elimination of an excess of accumulated metals from the body are proposed.

Keywords Biosorbents · Metals · Biopolymers · Sorption capacity · Sorption isotherms

1 Introduction

A modern city dweller is exposed to various polymetallic effects of anthropogenic sources of pollution. The hazard of constant exposure to metals from the environment is due to their long half-life in the body (5 years or more, if absorption prevails over elimination), followed by a toxic effect on the whole body [1–5]. In order to protect the body against polymetallic influence, a method of biosorption is used. It is a preventive and curative intervention aimed to cease an effect of toxins of various origins and to eliminate them from the body. Due to its simplicity and efficiency, the method of biosorption is actively used both in clinical practice in the treatment of various diseases and in health programs of environmental rehabilitation to correct microelements contents [6–9]. Therefore, special requirements are imposed to drugs used as biosorbents that vary depending on specific goals and objectives of their use. This results in the development of new biosorbents, different in structure and composition, which bind metals in the gastrointestinal tract by means of adsorption, ion exchange, and complex formation and eliminate them from the body [10–13].

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The applicability of adsorption models, i.e., the models corresponding to the Langmuir model, might be due to pH-dependency of biosorption. A metal ion is a chelator in a bulk solution and forms multidentate surface complexes. This combined effect can be responsible for the specific behavior of experimental metal sorption isotherms, measured at different pHs and described in [14]. This concept finds its support in numerous investigations performed with the use of a model biosorbent and Cu, Cd, and Pb as heavy metals.

To enhance the metal elimination capacity of a biosorbent, a new idea of producing a hybrid biosorbent matrix by combining two different biosorbents was tested for the sorption of Cd(II) and described in [15]. When two biosorbents were hybridized to form a HB matrix, the combined biosorption capacity was increased by 59.17% as compared to individual abilities of biosorbents. The kinetics of equilibrium was fast, with approximately 88% of Cd(II) biosorption taking place within 30 min. Biosorption kinetics and equilibrium followed the pseudo-second-order kinetics and a Langmuir adsorption isotherm model.

A method of production of low-cost chitin/lignin biosorbents, presented in [16], shows an attractive and easy way with high efficiency of nickel and cadmium adsorption (88.0 and 98.4%, respectively).

Combined biosorbents, which may consist of two or more types of these chelators, are most advanced biosorbents. These drugs having a low total sorption activity, the future use of their properties will provide the body with useful trace elements and a high affinity for heavy metals and radionuclides. For the best use of these chelators, it is necessary to study isotherms of their absorption with different pH the internal environment of the human body [10–15].